

## **NEOS: Network Enabled Optimization Services**

Jason Sarich, Jorge Moré, and Todd Munson\*

Argonne National Laboratory

### **Summary**

*The NEOS Project is a collaborative effort between Argonne National Laboratory and Northwestern University. The NEOS Guide provides educational material and case studies, while the NEOS Server gives users access to high-quality numerical optimization software through the Internet. The Server has been redesigned and reimplemented in the Python language to be more reliable, scalable, portable, and maintainable than earlier releases. An XML-RPC interface to the Server has been added to improve interoperability with other services.*

The NEOS Server has been in existence for over ten years and now handles approximately 150,000 submissions per year from the academic, commercial, and government sectors. Figure 1 shows the growth in the number of submissions received by the Server. Over the years, the Server code had been extended by a variety of collaborators to provide additional features such as support for new clients, enhanced reliability, and improved scheduling. However, the code base had grown to such an extent that it was no longer practical to maintain.

Therefore, we redesigned and reimplemented the Server to improve maintainability and to reuse existing technologies without impacting reliability, scalability, and portability. The new version, NEOS Server 5, is now being extensively tested prior to replacing the current version. We highlight here some of the advantages of the new server.

**Easier Maintenance.** To implement the Server and communication package, we

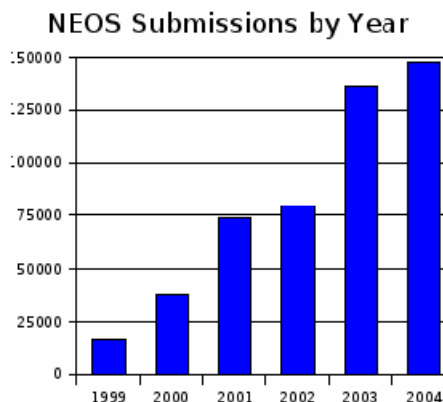


Figure 1. Number of submissions made to the NEOS Serve over the past four years.

chose the Python programming language rather than Perl and tcl/tk. Python has many of the same advantages of Perl, for example, portability and extensibility, but also has an integrated object-oriented architecture, offers clean error handling, and is much easier to read and maintain. In particular, instead of requiring over 12,000 lines of Perl and 5,000 lines of tcl/tk, NEOS Version 5 requires only 7,500 lines of Python.

**Improved Usability.** The mechanisms used to represent, transfer, and store submissions

\* Mathematics and Computer Science Division, (630) 252-4279, [tmunson@mcs.anl.gov](mailto:tmunson@mcs.anl.gov)

to NEOS Version 5 were chosen to take advantage of existing standards and software. Instead of using homegrown parsing utilities, communication protocols, and database management, the new version now relies on XML to represent the data, XML-RPC for communications, and MySQL for database management. The reuse of existing software that is maintained and well documented not only allows us to concentrate our efforts on other needs but also provides a significant improvement in functionality, reliability, and usability over homegrown solutions.

The choice of XML-RPC, for example, gives users much more flexibility in accessing the NEOS Server from their own environments. Previously, the only published ways to access the NEOS Server were through Web Forms, E-mail, or the NEOS Submission Tool or from the AMPL or GAMS modeling languages by using the Kestrel clients we developed. Many users, however, have asked about accessing the NEOS Server from other environments, such as from a command line or inside a piece of software. Although technically possible, such an approach was cumbersome because it required users to write their own TCP/IP client socket code and crawl through the monolithic Perl and tcl/tk source code to find the required send and receive patterns. NEOS Version 5, on the other hand, has a published API (Application Programming Interface) callable through the XML-RPC protocol. In particular, users can now easily write their own clients that invoke the Server in a variety of programming languages by using XML-RPC.

***Simplified Usage Monitoring.*** The improvements from using the MySQL database are generally seen not by the users sending problems to the Server but rather by the administrators. MySQL lets

administrators easily monitor usage, quickly compile statistics, and flexibly mine the submissions based on different criteria. Further, it enables reliable tracking of available solvers, running processes, and jobs waiting to be scheduled. These features reduce the burden on the administrators to ensure that everything is configured correctly and running smoothly.

***Better Use of Resources.*** The abundance of job submissions received by the NEOS Server means that we must make effective use of the available computational resources. In particular, a priority queue has been introduced in the scheduler to prevent the previously common occurrence of several long-running jobs exhausting the available resources to a point where all incoming jobs are backed up for hours or days. In particular, some of the computational resources are reserved for short-running jobs; any job designated as “short” is allocated five minutes of computational time on these resources before it is terminated. Moreover, by taking advantage of the usability and portability of the Python language, machines using the Windows operating system can now be used to process the submissions, potentially increasing the pool of available resources.

Our next step is to complete the beta testing of NEOS Version 5 and use it to replace the current Server. We then plan to concentrate on adding new features to further reduce the administration burden and implement new abilities based on feedback from our user base.

**For further information on this subject contact:**

Todd Munson  
Argonne National Laboratory  
Mathematics and Computer Science Division  
tmunson@mcs.anl.gov  
630-252-4279